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Examination Requested

(54) **Data Re-recording Method and Apparatus**

Abstract

The present invention relates to a technique for re-recording data into an area on an optical disk in which recording errors occur. The data re-recording method of the present invention comprises a first process of storing a properly recorded sector number when it is determined as a normal recording state under which the data (EFM Data) is outputted with a predetermined period after the data starts to be recorded on the optical disk, or stopping the recording process if the data is not outputted with the predetermined period; a second process of reading out the stored sector number after the recording process on stops and loading the sector number when an EFM counter hold signal EFM CHS is outputted; a third process of performing an optical disk-ROM encoding or optical disk encoding process to generate the data (EFM Data) after returning to a position previous to a predetermined sector from a sector in which the data is properly recorded, and counting down a bit clock signal with a laser diode of a pickup device

turned off; and a fourth process of turning on the laser diode to perform the substantial recording process when a count value becomes zero. Accordingly, the data can be re-recorded on the area where the recording errors occur.

Representative Figure

Fig. 3

Specification

Brief Description on the Drawings

Figs. 1 (a) to (f) are respective waveforms of detection signals for explaining data formats on an optical disk on which data is properly recorded;

Figs. 2 (a) to (e) are respective waveforms of detection signals for explaining data formats on the optical disk on which the data is not properly recorded;

Fig. 3 is a block diagram showing a preferred embodiment of a data re-recording apparatus according to the present invention;

Figs. 4 (a) to (f) are respective waveforms of signals shown in Fig. 3; and

Fig. 5 is the flowchart for explaining the method for re-recording the data according to the present invention.

Reference numerals on main portions of the drawings

1: CD	2: Pickup device
3: EFM edge signal generator	4: 12_T detector
5: EFM counter	6: Digital signal processor
7: Microcomputer	

Detailed Description of the Invention

Object of the Invention

Technical Field to Which Invention Belongs and Prior Art

The present invention relates to a technique for re-recording data onto an optical disk, in particular, to a method and apparatus adapted for locating a portion in which error occurred and performing a data re-recording process on the portion when recording the data on a

recording/reproducing system to read the previously recorded data.

Recently, a rewritable optical disk, such as CD-R and CD-RW, is widely used for the data backup in a computer system. A device for recording/reproducing data into/from such a CD-R/RW (hereinafter, referred to as a CD device) receives from a host or a computer the data to be recorded, and records the received data onto the CD using a pickup device.

However, when external impact or disturbance is applied to the CD device while the data is recorded, the pickup device may deviate from a target position for reproducing or recording the desired data and be thereby moved to an undesired position.

Referring to Figs. 1 and 2, a case where the data is properly recorded onto the CD and a case where the data is not properly recorded onto the CD will be hereinafter described as follows.

If the recording error occurs in the CD device while recording the data on the CD (CD-R/RW), the recording process is stopped for securing the stability of the CD device. When the recording process is stopped while recording the data on the CD, the data recorded on the CD does not meet a data format structure prescribed in the CD standards. Thus, it is impossible to reproduce the data that has been properly recorded on the CD or to newly record data on the CD.

Fig. 1 shows a normal data format structure recorded on the CD, which is defined in the CD standards. Fig. 2 shows a data format structure after the recording process is stopped due to the external impact or disturbance which may occur while recording the data on the disk.

When recording the data on the CD using the CD device, the recording process is performed after a sync signal ATIP Sync as shown in Fig. 1 (b) is detected. In other words, when a user wants to record the data on the CD, a sub-code sync signal Sub_Code Sync as shown in Fig. 1 (c) should be provided on the disk within 0 to 2 EFM after the above sync signal ATIP Sync has been detected. At this stage, the data (EFM Data) is recorded on the CD. An actual data format recorded on the CD has a 1_EFM data format as shown in Fig. 1 (e).

The beginning of the data 1_EFM Data is synchronized with the EFM sync and has the total length of 588_channel Bit. Sync data in the 1_EFM data has a length of 24T, where 1T is equal to Bit_Clock (in case 'x1', Bit_Clock corresponds to 4.3218 MHz). The longest T comprises positive (+) and negative (-) segments of the 1_EFM sync, while the shortest T comprises a 3_T segment. Therefore, the data 1_EFM Data is comprised of pits having the length within a range of 3_T to 11_T.

Therefore, the detailed data format structure in which the data is properly recorded on the disk such as, CD-ROM, CD-Audio or CD-R/RW, has been explained with reference to Fig. 1.

However, when the recording process is stopped due to an external impact or disturbance while recording the data using the CD device, a portion in which the data is not recorded on the CD as shown in Fig. 2 (a) may be produced. In such a case, this CD cannot be used later.

Problems to be Solved by the Invention

As described above, the conventional CD device has a problem in that it is impossible to reproduce the properly recorded data from the CD or to record other data on the CD since the CD does not meet the data format structure prescribed in the CD standards when the recording process is stopped due to the external impact or disturbance during the data recording.

In order to solve such a problem, a technique for causing an empty area to be later occupied by a dummy data was proposed. However, according to the technique, the disk can be used again, but the data already recorded on the disk cannot be reproduced.

Accordingly, an object of the present invention is to provide a method and apparatus capable of locating a bit position in which an error occurs and re-recording the data thereon in a case where the error occurs during the data recording.

Constitution and Operation of the Invention

In order to achieve the object of the present invention, a method for re-recording data, comprising a first process S1-S3 of storing a properly recorded sector number when it is determined as a normal recording state under which the data (EFM Data) is outputted with a predetermined period after the data starts to be recorded on a CD, or stopping the recording process if the data is not outputted within the predetermined period; a second process S4-S7 of reading out the stored sector number after the recording process stops and loading the sector number when an EFM counter hold signal EFM CHS is outputted; a third process S8-S11 of returning to a position previous to a predetermined sector from a sector in which the data is properly recorded, performing a CD-ROM encoding or CD encoding process to generate the data (EFM Data), and counting down a bit clock signal with a laser diode of a pickup device turned off; and a fourth process S12-S13 of turning on the laser diode to perform the substantial

recording process when a count value becomes zero.

Fig. 3 shows a block diagram of a preferred embodiment of a data re-recording apparatus for achieving the object of the recent invention. As shown in the figure, the apparatus comprises an optical pickup device 2 for scanning the CD 1 to record the data on or read the previously recorded data (EFM Data) from the CD 1; an EFM edge signal generating unit 3 for scanning the data (EFM Data) reproduced from the CD 1 by the optical pickup device 2 and outputting an edge detecting signal ED thereof; a 12_T detector 4 for identifying whether the data (EFM Data) is outputted from the pickup device 2 within a predetermined period 12_T and outputting an EFM counter hold signal EFM CHS when the EFM data is not outputted; an EFM counter 5 for counting the edge detecting signal ED after being reset by a sub-code sync signal Sub-Sync, causing the counter to be held by the EFM counter hold signal EFM CHS at the time when the recording error is detected, and then storing a count value counted until the recording error occurs, in order to detect from which segment in one sector the data (EFM Data) is not generated; a digital signal processor 6 for generating the sub-code sync signal Sub-Sync based on the data (EFM Data), in order to locate a portion in which the recording error occurs, after the sub-code sync signal Sub-Sync is generated; and a microcomputer 7 for recognizing the portion on the CD 1 in which the recording error occurs, based on the EFM counter hold signal EFM CHS and the count value held in the EMF counter 5, and then controlling the pickup device 2 so that the data can be re-recorded into the portion. The process of the present invention will be hereinafter described in detail with reference to Figs. 1, 2, 4 and 5.

In case a CD device properly performs the process for recording the data onto the CD 1, the data format on the CD 1 is configured as shown in Fig. 1 (a). The data begins to be recorded on the CD 1 after the detection of a sync signal ATIP Sync contained in a ATIP (Absolute Time In Pre-groove) data on the CD 1 as shown in Fig. 1 (b).

When the data properly recorded on the CD 1 is read out using the pickup device 2, the sync signal ATIP Sync is extracted from the read data as shown in Fig. 1 (b). Further, the sync signal Sub-Code Sync related to the data recorded on the CD 1 is outputted as shown in Fig. 1 (c). Furthermore, a 1_EFM sync waveform is also outputted from a sync segment of the 1_EFM data (Fig. 1 (f)).

If the data is properly recorded on the CD 1, the sync signals, ATIP Sync and Sub-Code

Sync, is outputted every 13.3ms at 'x1' speed, as shown in Figs. 1 (b) and (c), and the 1_EFM sync data is outputted every 13.3ms/98. Such an output of the 1_EFM sync data is based on the reasons that one sector (one ATIP or one sub-code segment) on the CD 1 is consisted of 98_EFM data.

Therefore, if the data is not properly recorded on the CD 1 as shown in Fig. 2 (a), the sync signal ATIP Sync will continuously be outputted regardless of the data recording process on the CD 1. On the other hand, the sub-code sync signal Sub-Code Sync and the data 1_EFM Data is not outputted from the portion in which the data is not recorded, as in Figs. 2 (c) and (d).

In other words, the fact that the sub-code sync signal Sub-Code Sync or the data 1_EFM Data is not outputted implies that a portion in which the data is not recorded exists on the CD 1. Such a recording error may occur for any data of the data 1_EFM Data as shown Fig. 2 (e).

If the data recording error occurs due to the external impact or disturbance while the data is recorded on the CD 1 using the pickup device 2, the microcomputer 7 stops the recording process in order to locate the portion in which the recording error occurred, and then reads the recorded sector.

The data reproduction for the CD 1 is now performed to detect the portion in which the recording error occurred. Then, the waveforms, which are denoted by solid lines as shown in Figs. 2 (b)-(d), are outputted from a portion in which the data is properly recorded, whereas only the sync signal ATIP Sync is outputted from the portion in which the data is not further recorded.

The portion in which the data (EFM Data) is not recorded on the CD 1 is formed at the time when the EFM counter hold signal (EFM CHS) is outputted from the 12_T detector 4 as shown in Fig. 4 (f). This is because the data 1_EFM Data recorded on the CD 1 has the segment within a range of a minimum 3_T to a maximum 11_T, it means that the data (EFM Data) is not recorded on the CD 1 if the data (EFM Data) greater than the 12_T is not outputted.

Since the portion where the recording error occurred should be located with reference to T (which corresponds to 4.3218 MHz, at 'x1' speed), a bit clock signal Bit CLK shown in Fig. 4 (b) is supplied to the 12_T detector 4. Then, the 12_T detector 4 measures the segment of the data 1_EFM Data, based on the bit clock signal Bit CLK.

To measure the segment of the data (EFM Data), the EFM edge signal generator 3 receives the data (EFM Data) shown in Fig. 4 (c) from the pickup device 2, and then outputs the

edge detecting signal ED as shown in Fig. 4 (d).

In order to determine which segment in one sector the data (EFM Data) is not generated, the EFM counter 5 is reset by the sub-code sync signal Sub-Sync as shown in Fig. 4 (e), which is inputted from the digital signal processor 6, and then starts counting up the edge detecting signal ED from zero.

Thereafter, if the sub-code sync signal Sub-Sync subsequent to the sector which was successfully recorded is inputted from the digital signal processor 6, the count value thus far is reset again.

However, if the EFM counter hold signal EFM CHS is inputted from the 12_T detector 4 while the EFM counter 5 counts up the edge detecting signal ED, the count value thus far will be stored. The stored count value of the edge detecting signal ED indicates a position where the recording error is generated from after the sub-code sync signal Sub-Sync is detected. It is noted that the stored position of the EFM error is used to determine when the diode in the pickup device 2 turns on when the recording process is resumed later.

In other words, in order to locate the portion in which the data (EFM Data) greater than 12_T is not recorded, the EFM edge signal generator 3 outputs the edge detecting signal ED as shown in Fig. 4 (d) and the EFM counter 5 counts the outputted edge detecting signal ED.

Moreover, in order to locate the portion in which an error occurs after the sub-code sync signal Sub-Sync is generated, the digital signal processor 6 produces the sub-code sync signal Sub-Sync shown as in Fig. 4 (e), based on the data (EFM Data) outputted from the pickup device 2, and provides the sub-code sync signal to the EFM counter 5 as a reset signal.

The value stored in the EFM counter 5 is one (1) until the EFM counter hold signal EFM CHS shown in Fig. 4 (f) is outputted followed by a recording error. In other words, it would be recognized that the recording error occurs, following the 1_channel bit after the sub-code sync signal Sub-Sync is generated.

If the EFM counter hold signal EFM CHS is outputted from the 12_T detector 4, the microcomputer 7 causes the control operation to stop in order to detect the portion in which the EFM error occurred, and then begins the CD-ROM encoding (in case of ROM data) or CD encoding process, from a sector previous to two sectors with respect to the relevant error sector. Thus, the EFM data is generated, but the power is not supplied to the laser diode in the pickup

device 2.

When the CD encoding process is conducted for the sector in which the recording error occurs, the EFM counter 5 counts down the bit clock signal Bit CLK, and thus, the count value starts to be decreased. When the count value becomes zero, the power is immediately provided to the laser diode and the data re-recording process is resumed. It is understood that the recording error starts to occur on the CD 1 at this stage.

Effect of the Invention

As described above in detail, the present invention has an advantage in that the recorded data or the optical disk itself can be efficiently utilized by locating the position in which the recording error occurred and re-recording the data thereon, considering that the ATIP sync signal is properly outputted, but both the sub-code sync signal and the EFM data are not outputted from the error position in a case where the recording error has occurred due to the external impact or disturbance while recording the data on the optical disk.

(57) Claims

1. A method for re-recording data, comprising:

a first process of storing a sector number which is determined as a normal recording state under which the data is outputted with a predetermined period after the data begins to be recorded, or stopping a recording process if the data is not outputted within the predetermined period;

a second process of reading out the stored sector number;

a third process of reproducing the data after returning to a position prior to a predetermined sector from the sector in which the data is properly recorded, and counting a clock signal; and

a fourth process of performing the recording process when a count value becomes zero.

2. The method as claimed in Claim 1, wherein the first process is using an EFM counter in which an edge detecting signal for the data is used as input data and which is reset by a sub-code

sync signal in a periodic manner and is count-held by an EFM counter hold signal so as to store an area in which the recording error has occurred in the sector.

3. The method as claimed in Claim 1, wherein the sector number read in the second process is loaded when the EFM counter hold signal is outputted.

4. A data re-recording apparatus, comprising:

an edge signal generating unit for scanning data outputted from a disk and outputting an edge detecting signal;

a data detector for identifying whether the data is outputted within a predetermined period of time;

a counter for counting the edge detecting signal to detect a portion where the data is not generated from one sector, and storing a count value counted until a recording error occurs;

a digital signal processor for generating a sync signal based on the data in order to locate the portion in which the recording error occurs; and

a microcomputer for identifying the portion where the recording error has been occurred and then causing the data to be re-recorded thereon.

Fig. 1

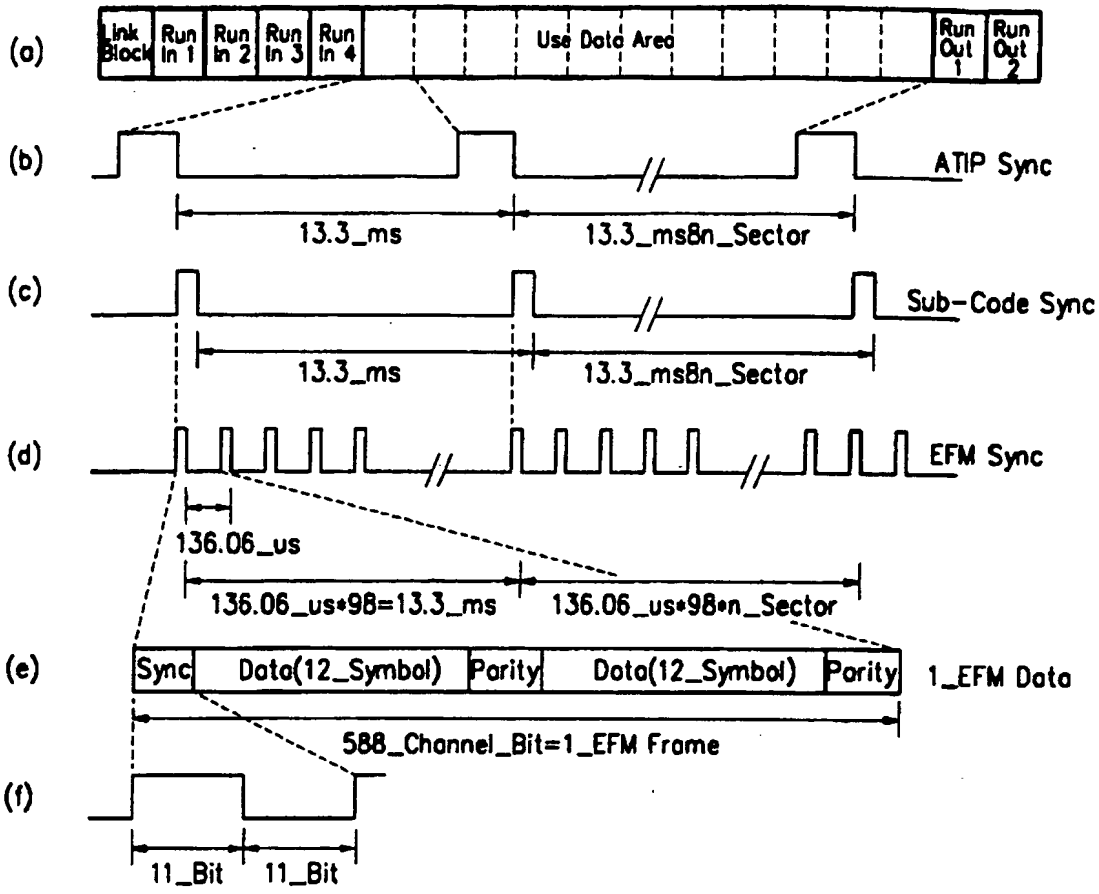

(a)
Link Block
Run In 1
Run In 2
Run In 3
Run In 4
Use Data Area
Run Out 1
Run Out 2
(b)
ATIP Sync
13.3_ms
13.3_ms8n_Sector
(c)
Sub-Code Sync
13.3_ms
13.3_ms8n_Sector
(d)
EFM Sync
136.06_us
136.06_us*98=13.3_ms
136.06_us*98*n_Sector
(e)
Sync
Data(12_Symbol)
Parity
Data(12_Symbol)
Parity
1_EFM Data
588_Channel_Bit=1_EFM Frame
(f)
11_Bit
11_Bit

Fig. 2

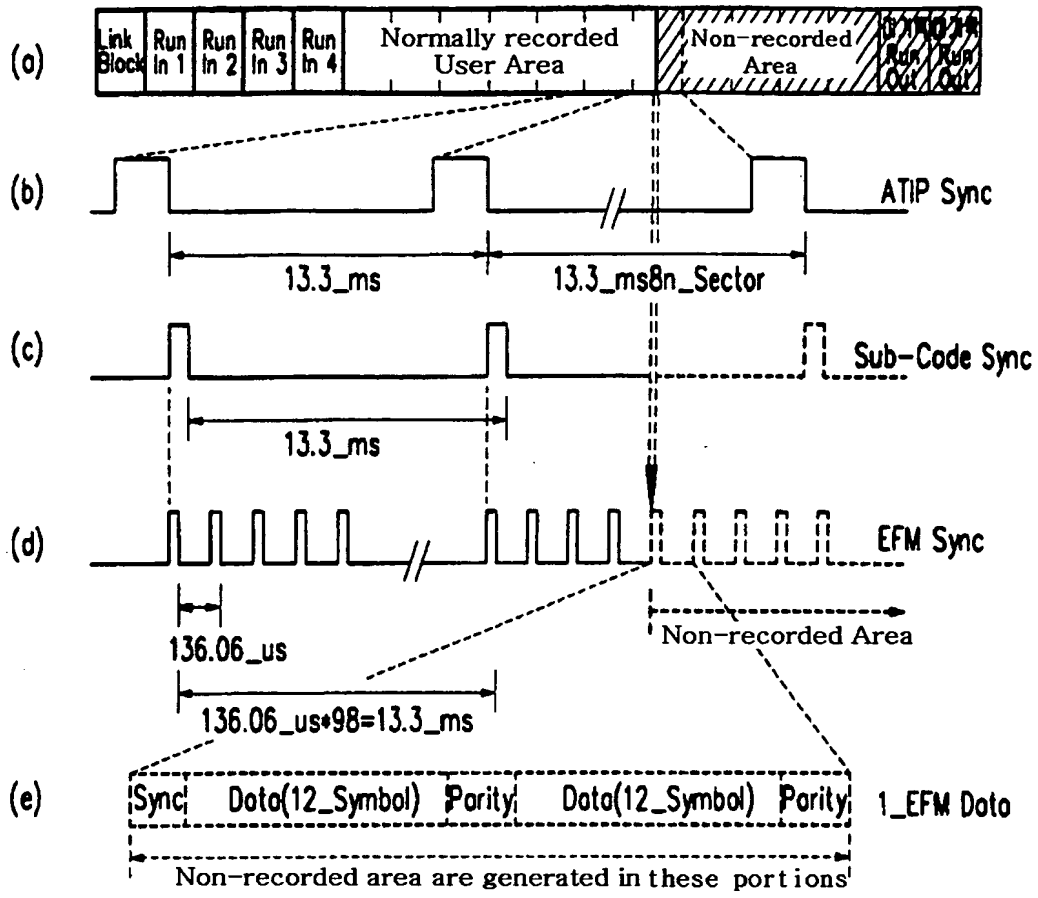

(a)
Link Block
Run In 1
Run In 2
Run In 3
Run In 4
Normally recorded User Area
Non-recorded Area
Run Out
Run Out
(b)
ATIP Sync
13.3_ms
13.3_ms8n_Sector
(c)
Sub-Code Sync
13.3_ms
(d)
EFM Sync
136.06_us
Non-recorded Area
136.06_us*98=13.3_ms
(e)
Sync
Data(12_Symbol)
Parity
Data(12_Symbol)
Parity
1_EFM Data
Non-recorded area are generated in these portions

Fig. 3

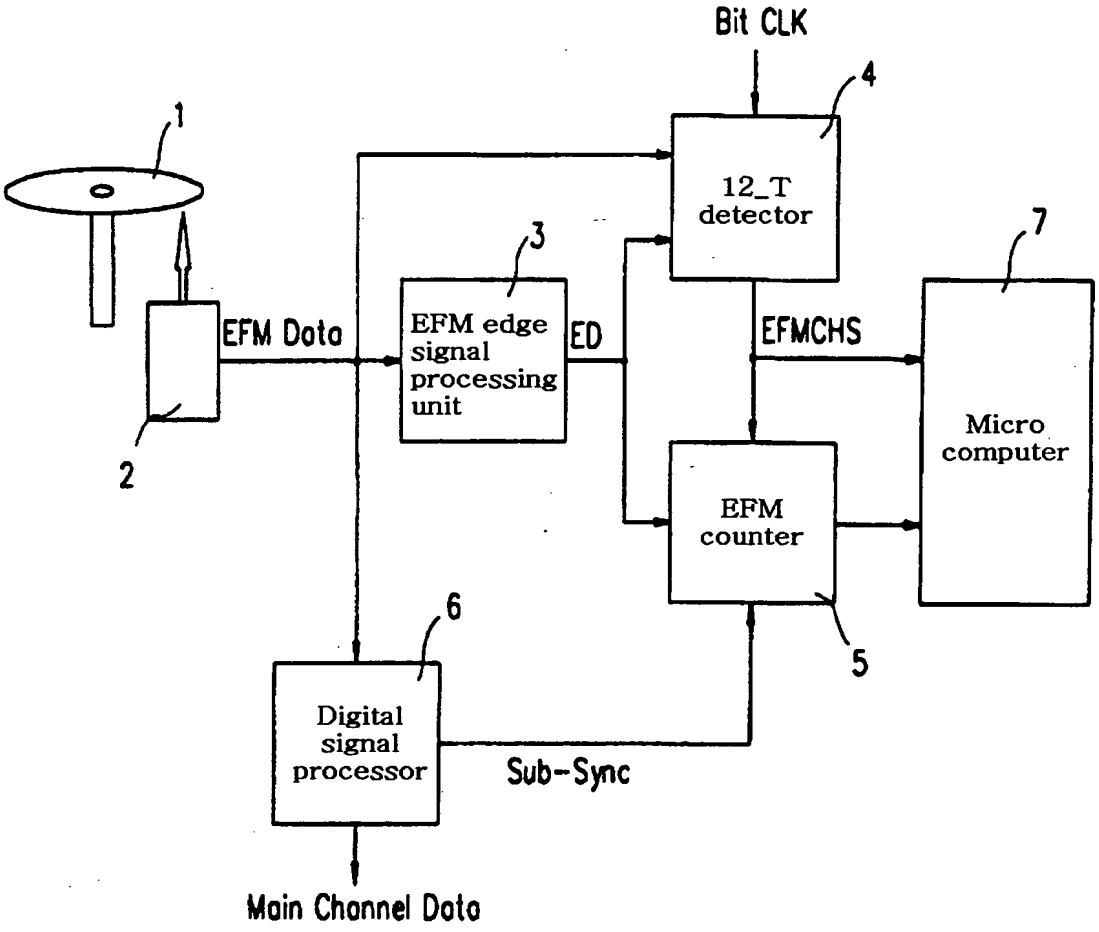

Bit CLK
4
1
12_T
detector
3
7
EFM Data
EFM edge
signal
processing
unit
ED
EFMCHS
Micro
computer
2
EFM
counter
6
5
Digital
signal
processor
Sub-Sync
Main Channel Data

Fig. 4

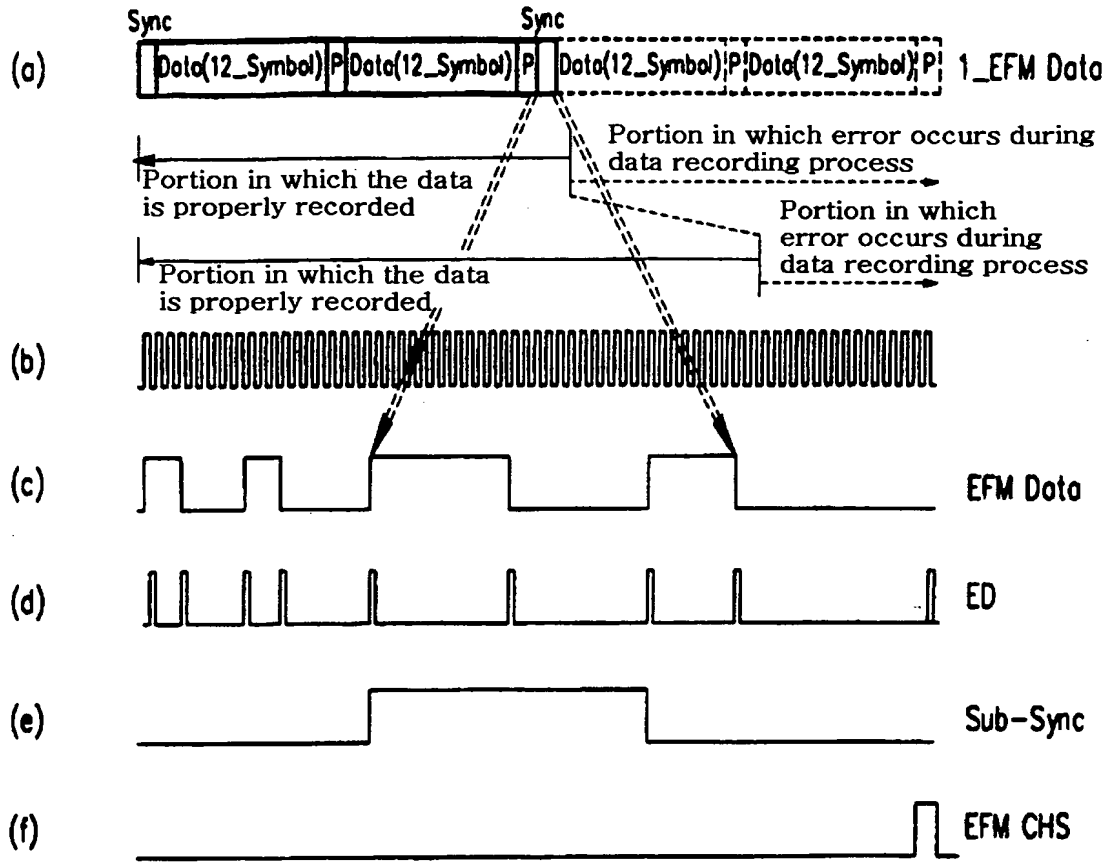
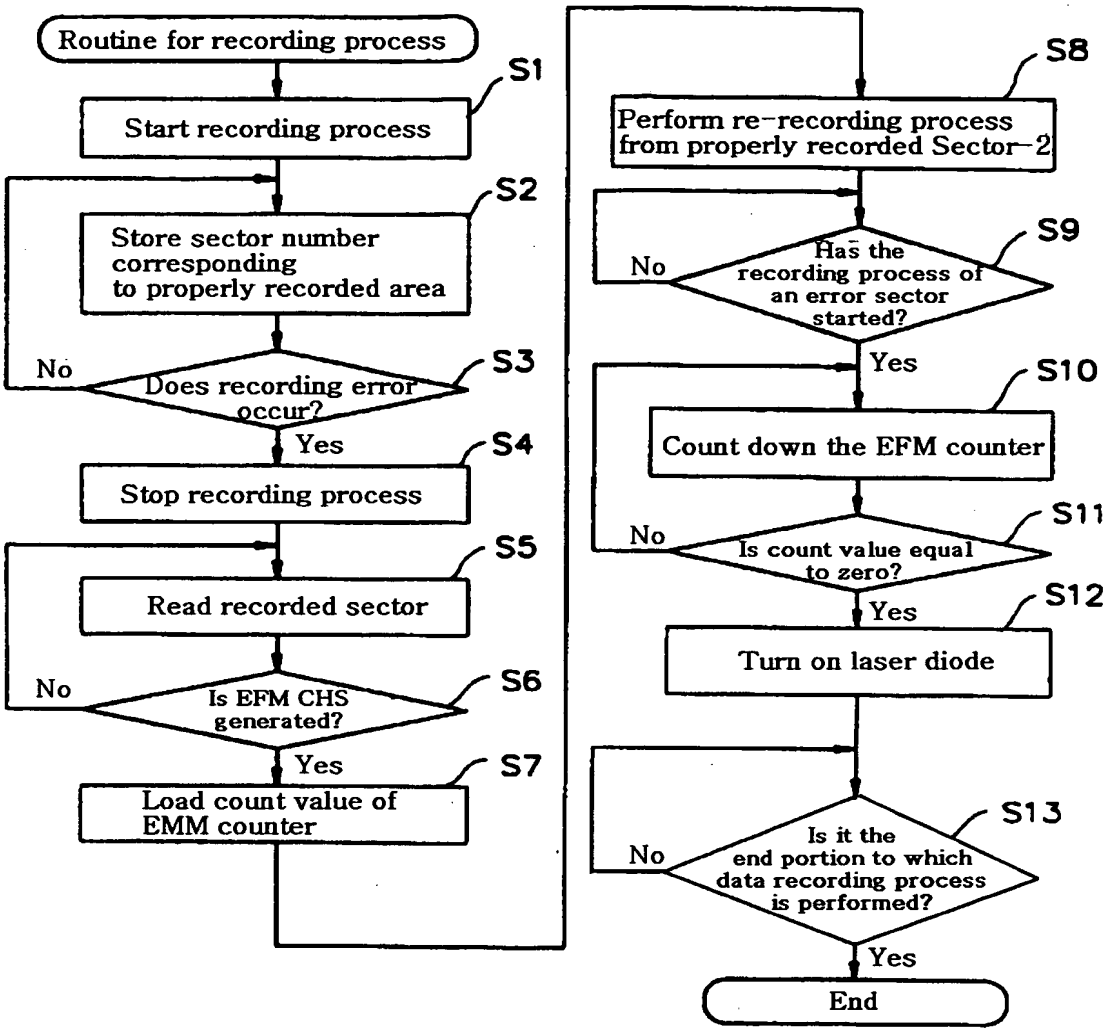

(a)
Sync
Sync
Data(12_Symbol)
P
Data(12_Symbol)
P
Data(12_Symbol)
P
Data(12_Symbol)
P
1_EFM Data
Portion in which error occurs during data recording process
Portion in which the data is properly recorded
Portion in which error occurs during data recording process
Portion in which the data is properly recorded
(b)
(c)
EFM Data
(d)
ED
(e)
Sub-Sync
(f)
EFM CHS

Fig. 5


Routine for recording process
S1
Start recording process
S2
Store sector number corresponding to properly recorded area
S3
No
Does recording error occur?
Yes
S4
Stop recording process
S5
Read recorded sector
S6
No
Is EFM CHS generated?
Yes
S7
Load count value of EMM counter
S8
Perform re-recording process from properly recorded Sector-2
S9
No
Has the recording process of an error sector started?
Yes
S10
Count down the EFM counter
S11
No
Is count value equal to zero?
Yes
S12
Turn on laser diode
S13
No
Is it the end portion to which data recording process is performed?
Yes
End